

Zero-Voltage Switch with Adjustable Ramp

Description

The integrated circuit, T2117, is designed as a zero-voltage switch in bipolar technology. It is used to control resistive loads at mains by a triac in zero-crossing mode.

A ramp generator allows power control function by period group control, whereas full-wave logic guarantees that full mains cycles are used for load switching.

Features

- Direct supply from the mains
- Current consumption ≤ 0.5 mA
- Very few external components
- Full-wave drive – no DC current component in the load circuit
- Negative output current pulse typ. 100 mA – short-circuit protected

- Simple power control
- Ramp generator
- Reference voltage

Applications

- Full-wave power control
- Temperature regulation
- Power blinking switch

Block Diagram

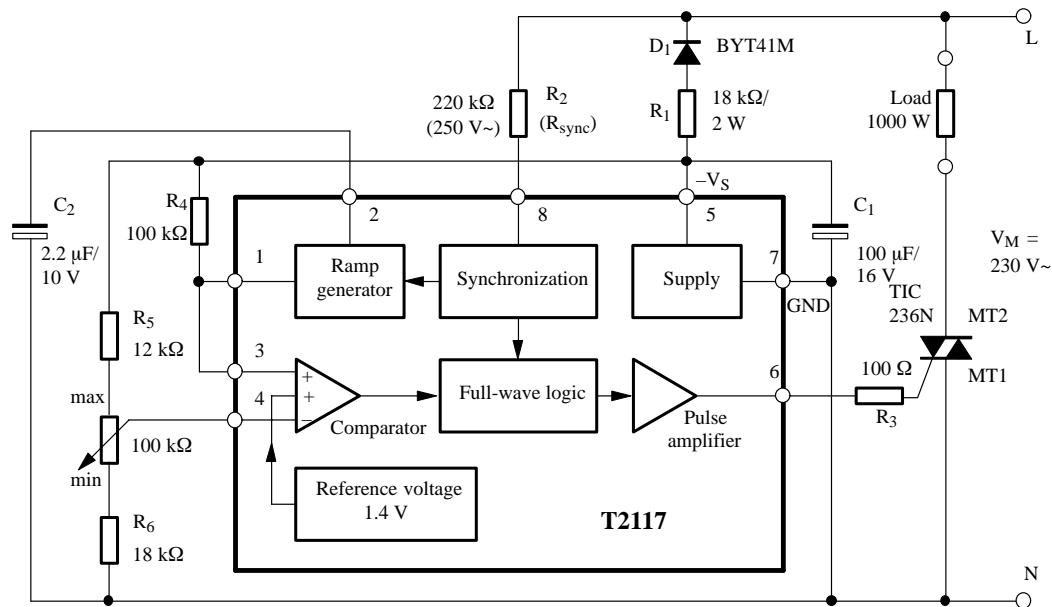


Figure 1. Block diagram with typical circuit, period group control 0 to 100%

Ordering Information

Extended Type Number	Package	Remarks
T2117-3AS	DIP8	Tube
T2117-TAS	SO8	Tube
T2117-TAQ	SO8	Taped and reeled

Pin Description

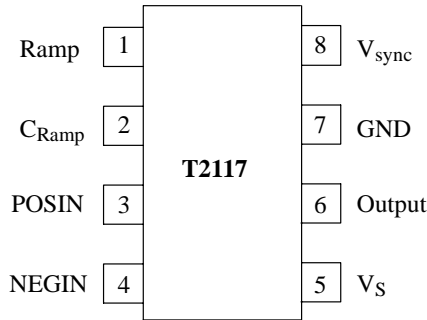


Figure 2. Pinning

Pin	Symbol	Function
1	Ramp	Ramp output
2	CRamp	Ramp capacitor
3	POSIN	Non-inverting comparator input
4	NEGIN	Inverting comparator input
5	VS	Supply voltage
6	Output	Trigger pulse output
7	GND	Ground
8	Vsync	Voltage synchronization

General Description

The integrated circuit T2117 is a triac controller for zero-crossing mode. It is designed to control power in switching resistive loads of mains supplies.

Information regarding supply sync. is provided at Pin 8 via resistor R_{sync} . To avoid DC load on the mains, the full-wave logic guarantees that complete mains cycles are used for load switching.

A fire pulse is released when the inverting input of the comparator is negative (Pin 4) with respect to the non-inverting input (Pin 3) and internal reference voltage. A ramp generator with free selectable duration can be performed by capacitor C_2 at Pin 2. The ramp function is used for open-loop control (figure 4), but also for application with proportional band regulation (figure 11). Ramp voltage available at capacitor C_2 is decoupled across the emitter follower at Pin 1. To maintain the lamp flicker specification, ramp duration is adjusted according to the controlling load. In practice, interference should be avoided (temperature control). Therefore, a two-point control is preferred to proportional control. One can use internal reference voltage for simple applications. In that case, Pin 3 is inactive and connected to Pin 7 (GND), see figure 13.

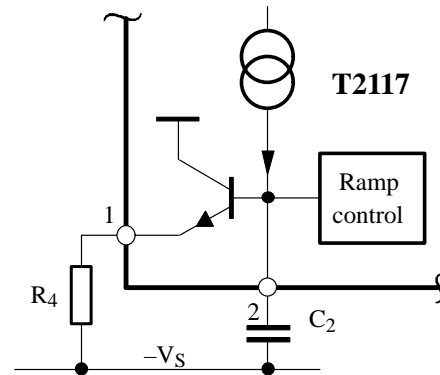


Figure 3. Pin 1 internal network

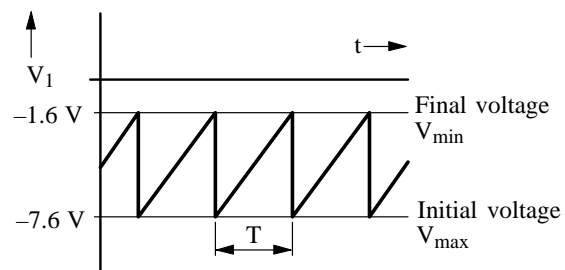


Figure 4. Threshold voltage of the ramp at $V_S = -8.8 \text{ V}$

Triac Firing Current (Pulse)

This depends on the triac requirement. It can be limited with gate series resistance which is calculated as follows:

$$R_{Gmax} \approx \frac{7.5 \text{ V} - V_{Gmax}}{I_{Gmax}} - 36 \Omega$$

$$I_p = \frac{I_{Gmax}}{T} \times t_p$$

where:

- V_G = Gate voltage
- I_{Gmax} = Maximum gate current
- I_p = Average gate current
- t_p = Firing pulse width
- T = Mains period duration

Firing Pulse Width t_p (Figure 5)

This depends on the latching current of the triac and its load current. The firing pulse width is determined by the zero-crossing detection which can be influenced with the help of sync. resistance, R_{sync} , (figure 6).

$$t_p = \frac{2}{\omega} \arcsin\left(\frac{I_L \times V_M}{P \sqrt{2}}\right)$$

whereby:

- I_L = Latching current of the triac
- V_M = Mains supply, effective
- P = Power load (user's power)

Total current consumption is influenced by the firing pulse width which can be calculated as follows:

$$R_{sync} = \frac{V_M \sqrt{2} \sin(\omega \times \frac{t_p}{2}) - 0.6 V}{3.5 \times 10^{-5} A} - 49 \text{ k}\Omega$$

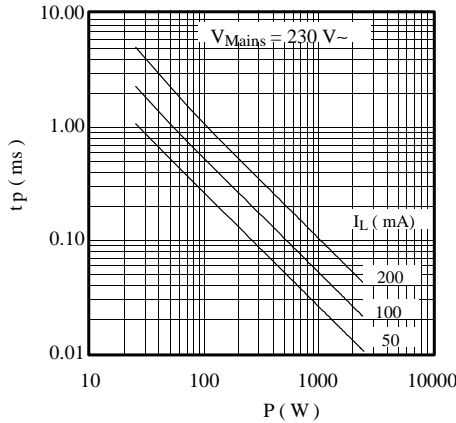


Figure 5. Output pulse width

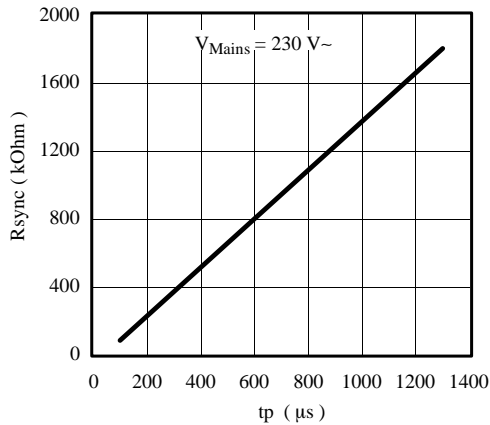


Figure 6. Synchronization resistance

Supply Voltage

The T2117 contains voltage limiting and can be connected with the mains supply via the diode D_1 and the resistor R_1 . Supply voltage between Pin 5 and 7 is limited to a typical value of 9.5 V.

The series resistance R_1 can be calculated (figures 7 and 8) as follows:

$$R_{1max} = 0.85 \frac{V_{Mmin} - V_{Smax}}{2 I_{tot}} ; P_{(R1)} = \frac{(V_M - V_S)^2}{2 R_1}$$

$$I_{tot} = I_S + I_P + I_x$$

whereby:

- V_M = Mains voltage
- V_S = Limiting voltage of the IC
- I_{tot} = Total current consumption
- I_S = Current requirement of the IC (without load)
- I_x = Current requirement of other peripheral components
- $P_{(R1)}$ = Power dissipation at R_1

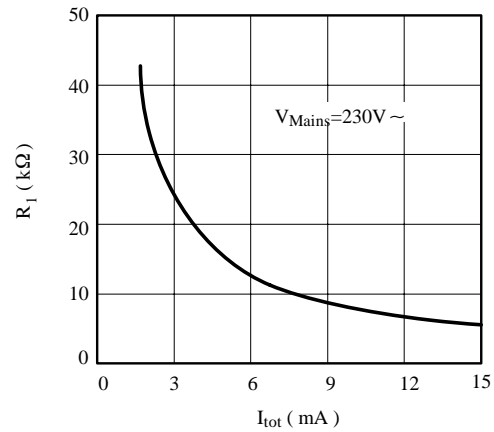


Figure 7. Maximum resistance of R_1

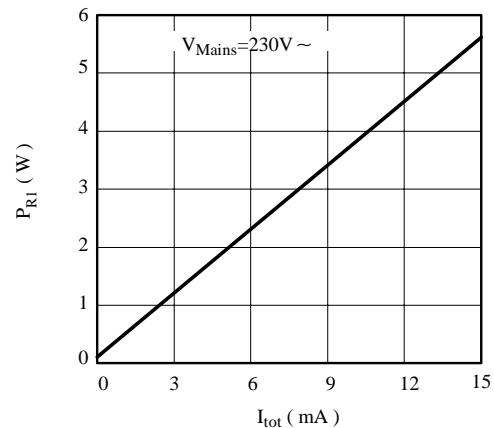


Figure 8. Power dissipation of R_1 according to current consumption

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply current Pin 5	$-I_S$	30	mA
Sync. current Pin 8	$I_{Sync.}$	5	mA
Output current ramp generator Pin 1	I_O	3	mA
Input voltages Pin 1, 3, 4, 6 Pin 2 Pin 8	$-V_I$	$\leq V_S$	V
	$-V_I$	2 to V_S	V
	$\pm V_I$	≤ 7.3	V
Power dissipation $T_{amb} = 45^\circ\text{C}$ $T_{amb} = 100^\circ\text{C}$	P_{tot}	400	mW
	P_{tot}	125	mW
Junction temperature	T_j	125	$^\circ\text{C}$
Operating ambient temperature range	T_{amb}	0 to 100	$^\circ\text{C}$
Storage temperature range	T_{stg}	-40 to + 125	$^\circ\text{C}$

Thermal Resistance

Parameter	Symbol	Value	Unit
Junction ambient SO8	R_{thJA}	200	K/W
Junction ambient DIP8	R_{thJA}	110	K/W

Electrical Characteristics

$-V_S = 8.8\text{ V}$, $T_{amb} = 25^\circ\text{C}$, reference point Pin 7, unless otherwise specified

Parameter	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Supply-voltage limitation	$-I_S = 1\text{ mA}$ Pin 5	$-V_S$	9.0	9.5	10.0	V
	$-I_S = 10\text{ mA}$ Pin 5	$-V_S$	9.1	9.6	10.1	V
Supply current	Pin 5	$-I_S$			500	μA
Voltage limitation	$I_8 = \pm 1\text{ mA}$ Pin 8	$\pm V_I$	7.7	8.2	8.7	V
Synchronization current	Pin 8	$\pm I_{sync}$	0.12			mA
Zero detector	Pin 8	$\pm I_{sync}$		35		μA
Output pulse width	$V_M = 230\text{ V}\sim$, $R_{sync} = 220\text{ k}\Omega$ Pin 6 $R_{sync} = 470\text{ k}\Omega$ Pin 6	t_p		260		μs
		t_p		460		μs
Output pulse current	$V_6 = 0\text{ V}$ Pin 6	$-I_O$	100			mA
Comparator						
Input offset voltage	Pin 3,4	$\pm V_{IO}$			15	mV
Input bias current	Pin 4	I_{IB}			1	μA
Common-mode input voltage	Pin 3,4	$-V_{IC}$	1		$(V_S - 1)$	V
Threshold internal reference	$V_3 = 0\text{ V}$ Pin 4	$-V_{Ref}$		1.4		V

Electrical Characteristics (continued)

$-V_S = 8.8\text{ V}$, $T_{\text{amb}} = 25^\circ\text{C}$, reference point Pin 7, unless otherwise specified

Parameter	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Ramp generator, figure 1						
Period	$-I_S = 1\text{ mA}$, $i_{\text{sync}} = 1\text{ mA}$, $C_1 = 100\text{ }\mu\text{F}$, $C_2 = 2.2\text{ }\mu\text{F}$, $R_4 = 100\text{ k}\Omega$ Pin 1	T		1.5		s
Final voltage	Pin 1	$-V_1$	1.2	1.6	2.0	V
Initial voltage	Pin 1	$-V_1$	7.2	7.6	8.0	V
Charge current	$V_2 = -V_S$, $I_8 = -1\text{ mA}$, Pin 2	$-I_2$	14	20	26	μA

Applications

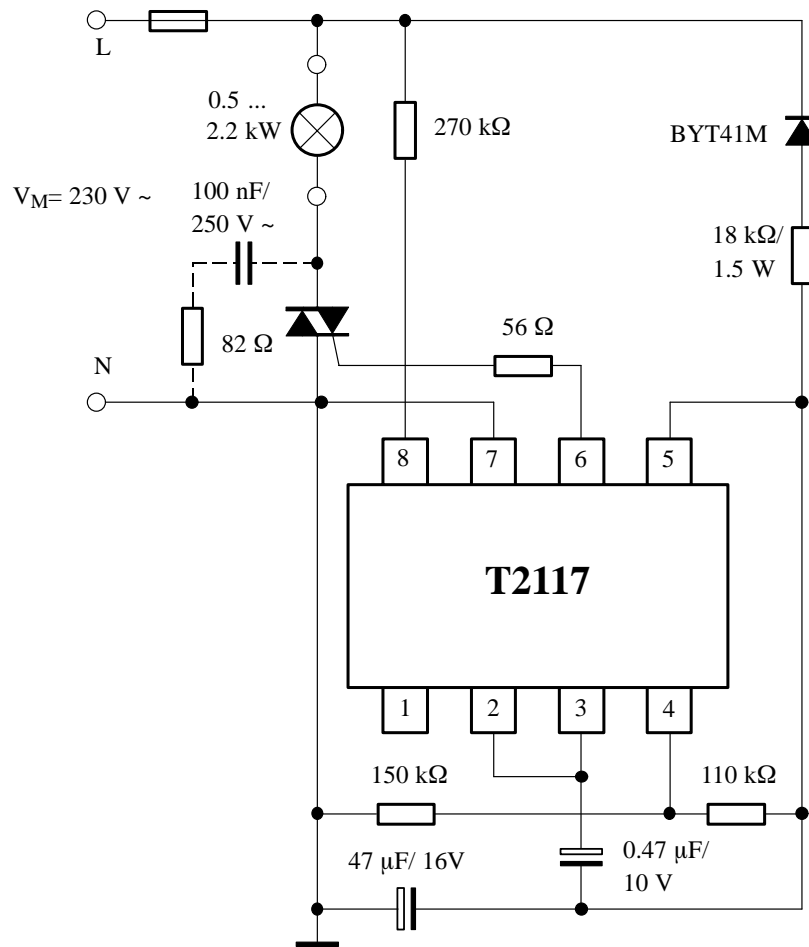


Figure 9. Power blinking switch with $f \approx 2.7\text{ Hz}$, duty cycle 1:1, power range 0.5 to 2.2 kW

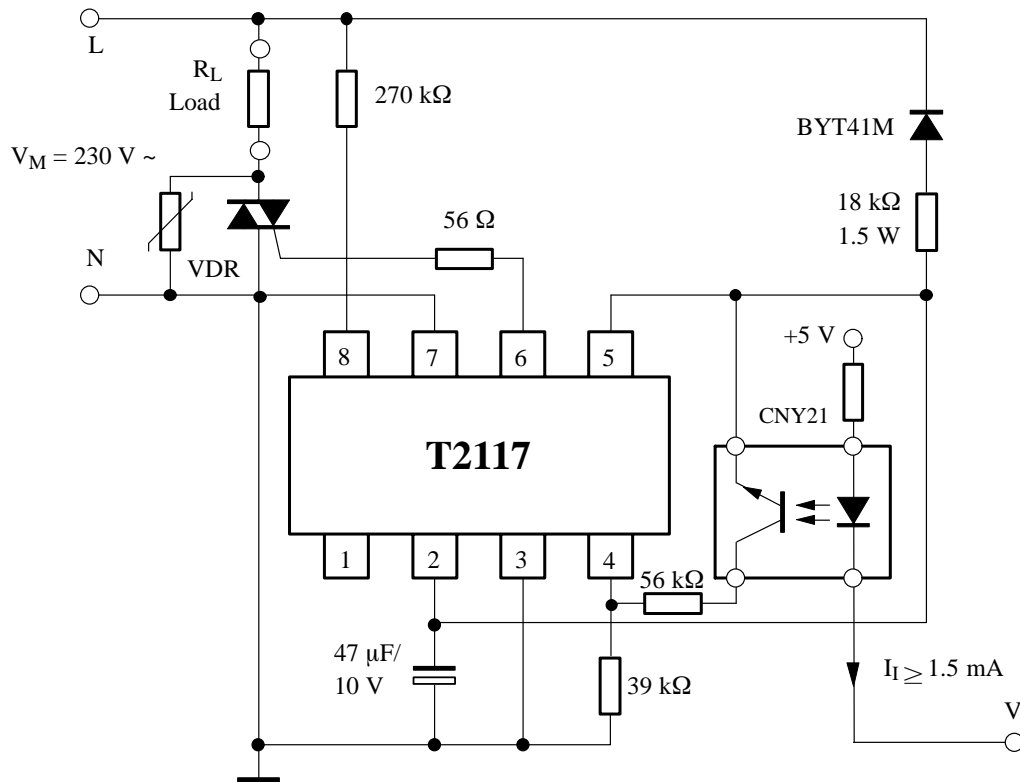


Figure 10. Power switch

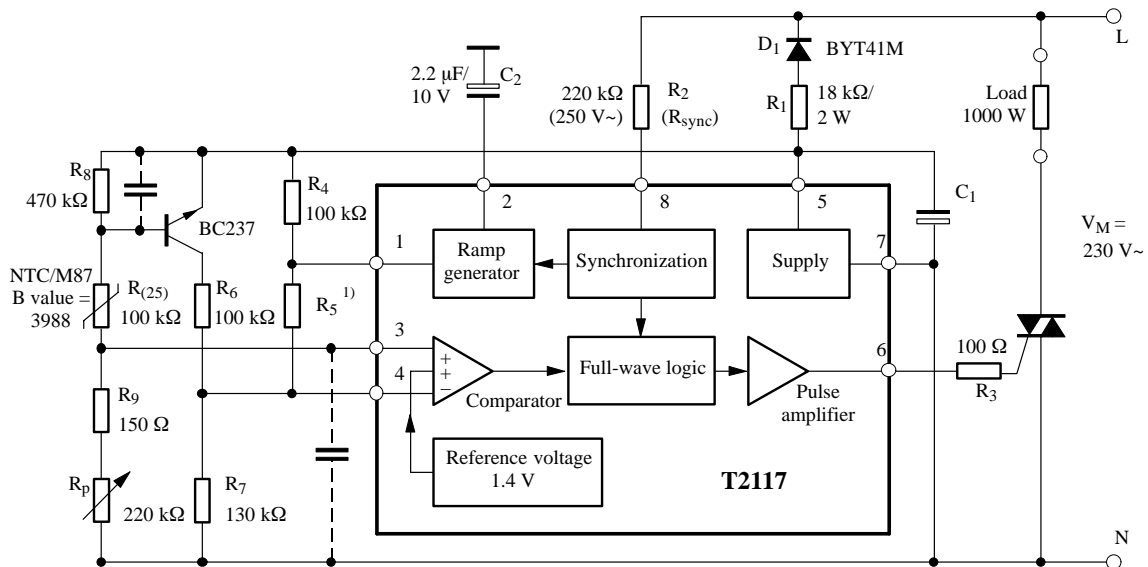


Figure 11. Temperature control 15 to 35°C with sensor monitoring
NTC-Sensor M 87 Fabr. Siemens

$$R_{(25)} = 100 \text{ k}\Omega / B = 3988 \Rightarrow R_{(15)} = 159 \text{ k}\Omega \quad R_5^{1)} \text{ determines the proportional range}$$

$$R_{(35)} = 64.5 \text{ k}\Omega$$

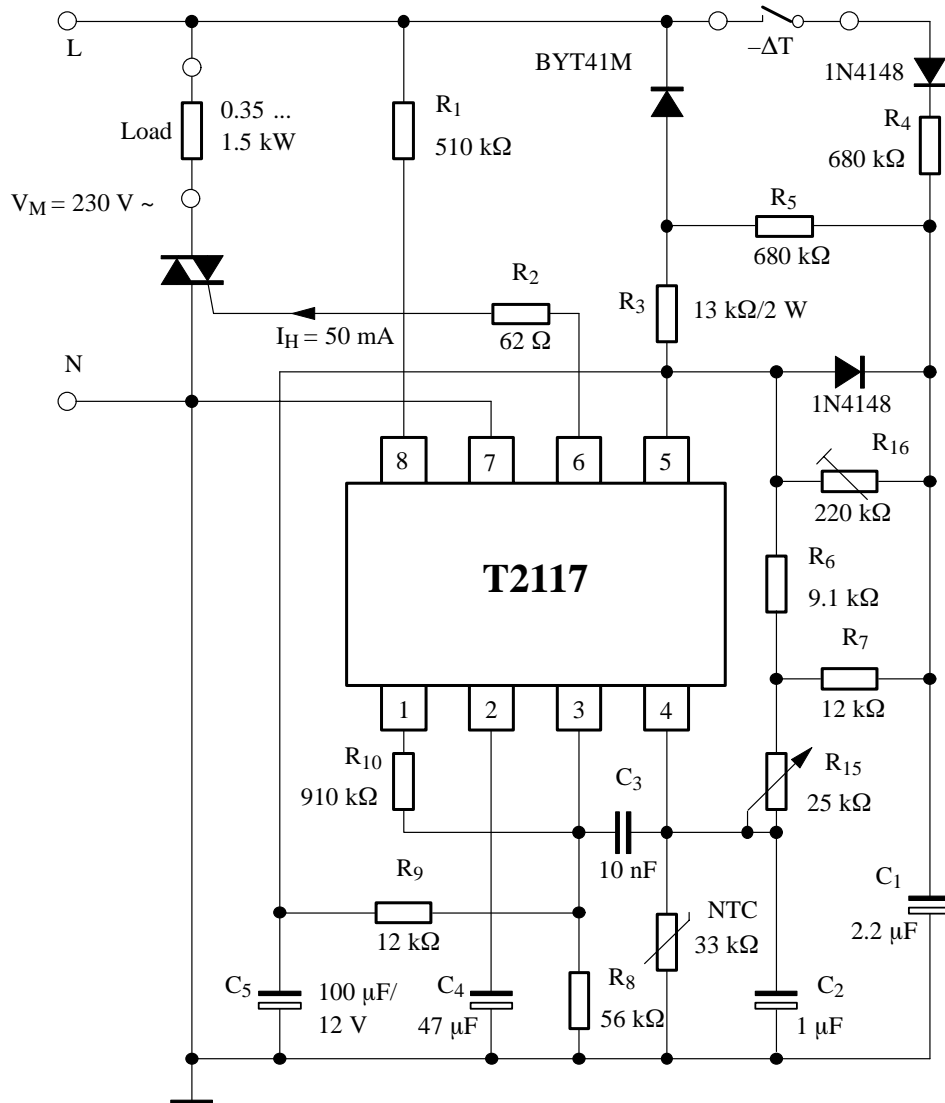


Figure 12. Room temperature control with definite reduction (remote control) for a temperature range of 5 to 30°C

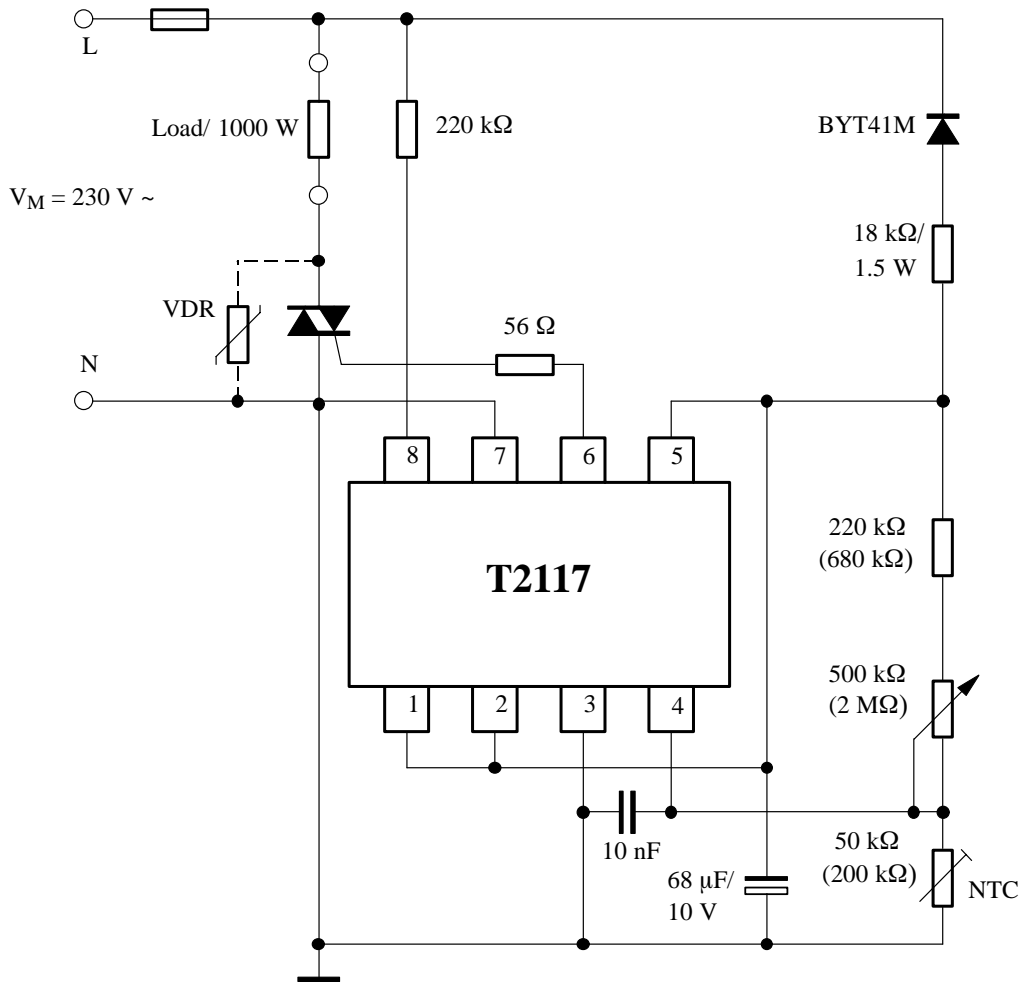


Figure 13. Two-point temperature control for a temperature range of 15 to 30°C

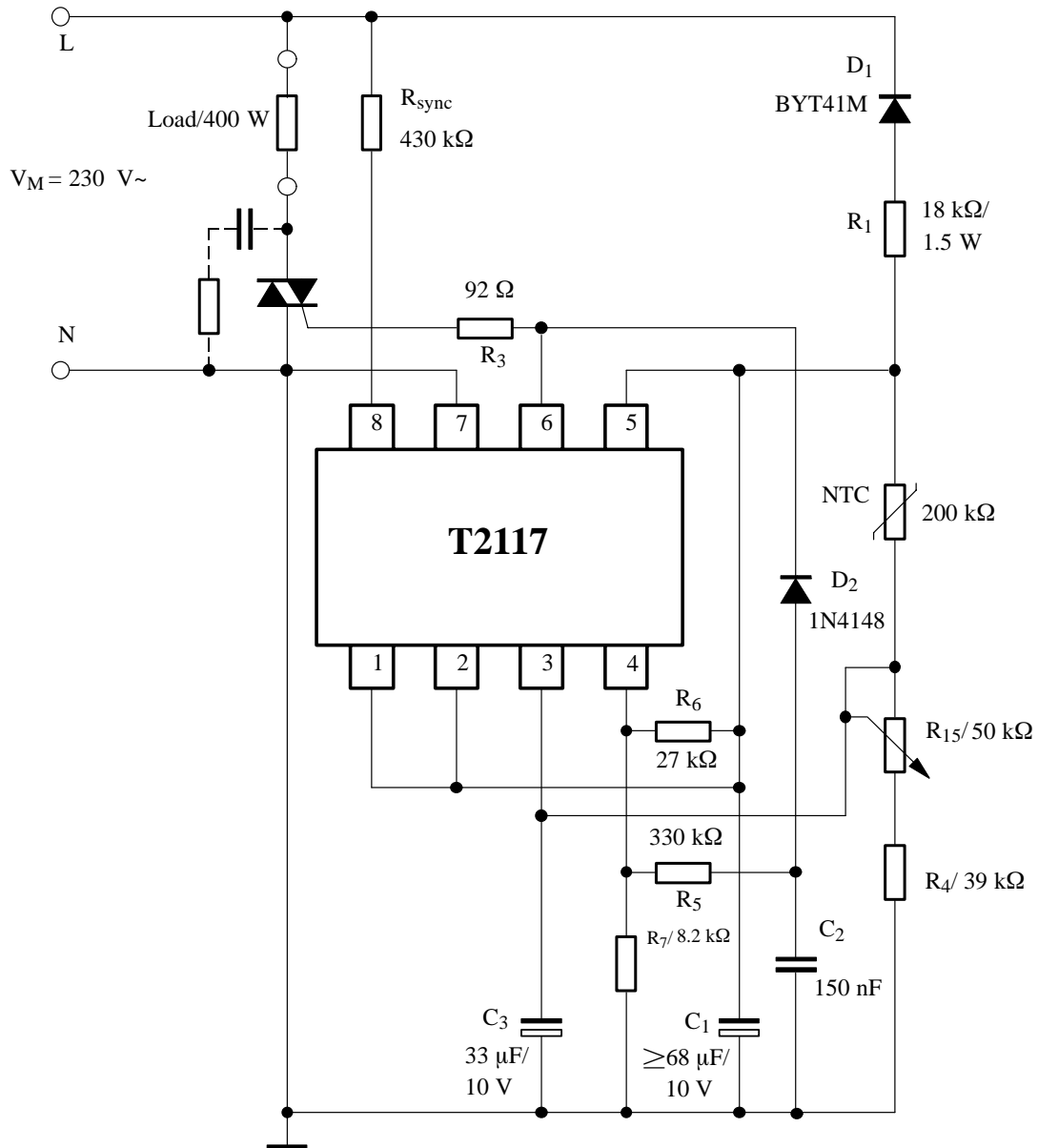
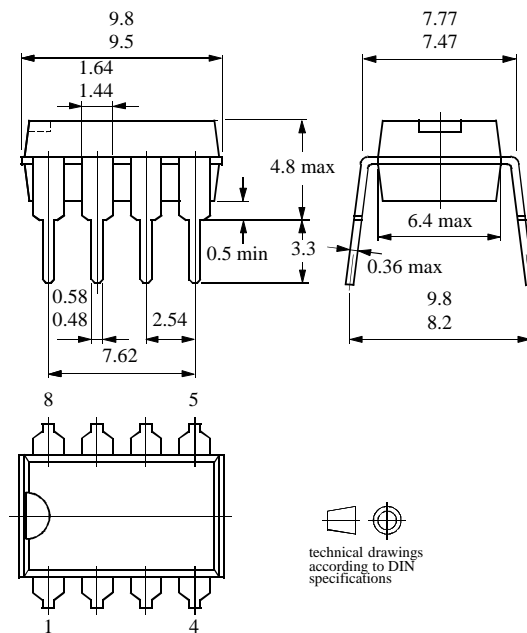


Figure 14. Two-point temperature control for a temperature range of 18 to 32°C and a hysteresis of $\pm 0.5^\circ\text{C}$ at 25°C

Package Information

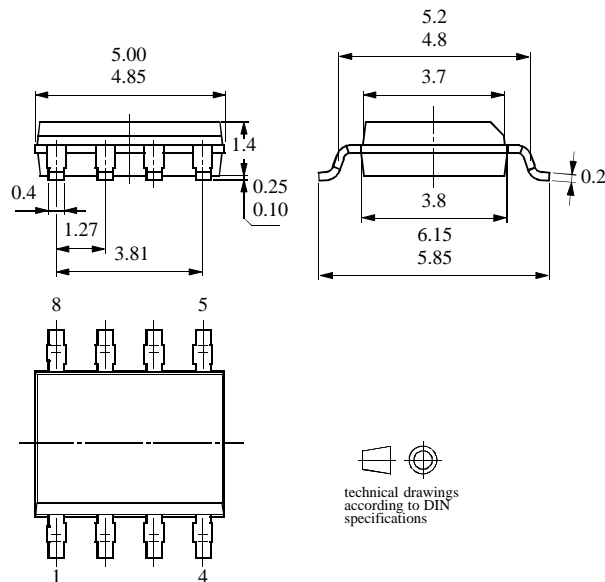
Package DIP8

Dimensions in mm



Package SO8

Dimensions in mm



Ozone Depleting Substances Policy Statement

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1. Meet all present and future national and international statutory requirements.
2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Atmel Germany GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively
2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

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Data sheets can also be retrieved from the Internet: <http://www.atmel-wm.com>

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